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Long Term Evolution Vs Worldwide Interoperability for Microwave Access

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***Abstract*—Mobile communication is developing very rapidly these days, new technologies are being introduced to facilitate the mobile users more from the technology. The past technologies are replaced by new ones such as LTE and WIMAX offering high availability and performance and fulfilling mobile user needs with high rates of quality of service . This paper provides comparison between LTE and WiMAX. Majorly the main issues will be considered are System Architecture and Physical Layer , in addition to comparison and contrasting various aspects such as transmission modes, duplexing types of the physical layer.**

I. INTRODUCTION

A closer look to LTE (Long Term Evolution) and WiMAX (World-wide Interoperability for Microwave Access) shows very clearly that they both are expected to be primary technologies for mobile broad- band wireless for the next decade. As with most emerging and competing technologies. The goal of the paper is to primarily focus on technical aspects as compared to business and strategic aspects. The article is organized as follows. Firstly, we describe the evolution of LTE and WiMAX as well as provide the primary motivations. A system- level comparison of LTE and WIMAX focusing on system-architecture and protocol stacks for the control and user is provided and the air interfaces for LTE and WiMAX described[1].

A. LTE

LTE stands for long term evolution next generation mobile broadband technology. promises data transfer rates of 100 mbps. based on UMTS
3G technology optimized for all-IP traffic.

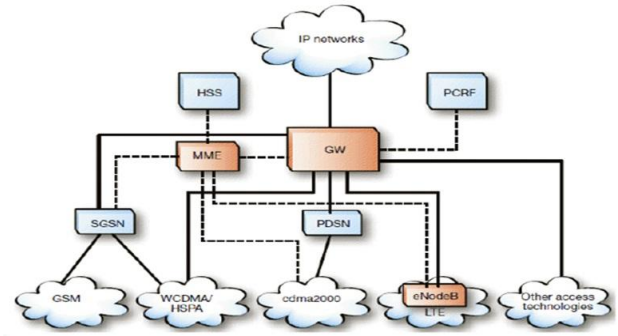

Fig 1. LTE Architecture[4]

B. WiMAX

Worldwide Interoperability for Microwave Access (WiMAX) is the common name associated to the IEEE 802.16a/REV d/e standards. These standards are issued by the IEEE 802.16 subgroup that originally covered the Wireless Local Loop technologies with radio spectrum from 10 to 66 GHz[2].

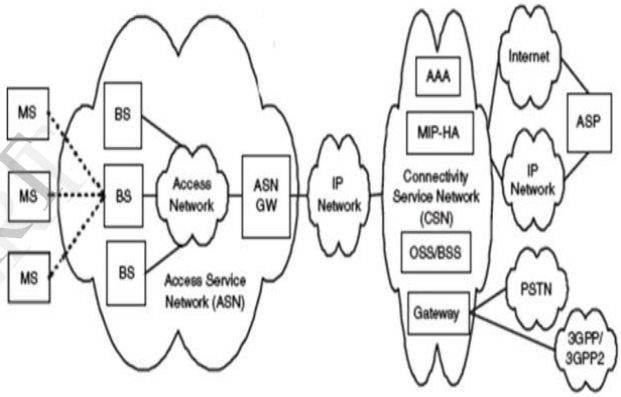

Fig 2. WiMAX Components[4]

II. MOTIVATION FOR LTE AND WIMAX

The primary motivations for both LTE and WiMAX are similar and can be stated as:

A. Mobile Data Network

The primary usage of both networks is to provide a data-centric network as compared to voice-centric network of 2G and 3G systems. This aspect is highlighted by the absence of any provisions to carry any circuit-type service. The networks do support voice, but in the form of packetized VoIP service.

B. Improve Spectral Efficiency

Given the scarcity of licensed spectrum, improving efficiency is a major impetus for both networks. The main technologies to enable higher efficiency are to move towards higher modulation schemes (like 64 QAM), smart antenna techniques (MIMO, Beam Forming, etc) and OFDM[2].

C. *Spectrum Flexibility*

Unlike previous networks which operated on a fixed width spectrum (5 MHz for WCDMA and 1.25 MHz for CDMA-DO), both networks allow scalability from 1.25 MHz up to 20 MHz

D. *Higher Peak Data Rates*

Both networks attempt to improve the peak data rate on the downlink and uplink so that high data rate services such as high-definition video can be transmitted over broadband wireless links. Specifically, the goal is to increase the peak rates from range of (3-10) Mbps to (50-100) Mbps[3].

E. *Lower Infrastructure Costs*

Traditional cellular networks comprise a combination of TDM and packet infrastructure partly because of the need to carry circuit voice. LTE and WiMAX networks simplify the network considerably, migrating towards an all-IP infrastructure relying on IP network for transporting data and control messages. Additionally, both networks embody a design principle of flattening the architecture wherein the system eliminates a centralized base station controller (or Radio Network Controller (RNC)) in favor of distributing the functionality to Base Stations and Access Gateways

III. AIR INTERFACE

A. *Scalable Bandwidth*

3G technologies were designed to operate in a fixed bandwidth. For example, WCDMA bandwidth is 5 MHz. Unlike 3G, LTE and WiMAX are defined over a wide range of bandwidth ranging from 1.5 to 20 MHz. This allows the operators (service providers) deployment flexibility based on spectrum availability and capacity/ coverage needs [1].

B. *Downlink Transmission*

LTE and WiMAX deploy OFDM for downlink transmission. The transmission is divided into time intervals (frames) and the spectrum is divided into a number of subcarriers. Downlink Resources are managed by a scheduler at the Base Station that determines the number of subcarriers and time intervals for each user on the downlink and uplink.

C. *MIMO*

LTE and WiMAX allow for MIMO options comprising STBC (Space Time Block Coding) or SM (Spatial Multiplexing). WiMAX Release 1.0 defines
2 x 2 MIMO (and higher MIMO are being developed for future release). The LTE specification allows up to 4 x 4 MIMO.

Remarks	
Scalable Bandwidth	LTE: 1.4,3, 5, 10, 15, 20 MHz WiMAX: 1.25, 5, 10 MHz
Downlink Transmission	OFDMA
MIMO	2x2 (STBC and SM)

Table 1 provides the key similarities between LTE and WiMAX air Interface.[4]

IV. DIFFERENCES

A. *Duplexing Mode*

WiMAX is currently defined as a TDD system (though there are plans to define a FDD system in a future release). LTE has a defined TDD and FDD specifications, though most deployments are expected to be FDD. FDD uses paired spectrum (one for uplink and other for downlink). TDD on the other hand requires contiguous spectrum. Cellular/3G systems are FDD and cellular operators have unused (or in-use) paired spectrum that can be utilized for LTE. One of the key benefits of TDD is the reciprocal nature of the channel, facilitating the use of beam forming techniques to provide improved edge of cell performance as well as stabilizing multipath in wide area MIMO deployments. An- other technical aspect of TDD and FDD systems is the synchronization requirement. TDD systems have to be synchronized to ensure non-interference of uplink and downlink burst across different BS. FDD systems do not require this form of synchronization. A typical way of implementation of achieving the synchronization is by using an accurate GPS receiver than can provide a pulse at 1 PPS (Pulse per second). In low end base stations such as Pico Base Stations and Femto Base Stations, the additional GPS receiver cost becomes an important consideration while in indoor Femto Base stations, the non- availability of GPS signals becomes an additional issue. FDD is a natural choice for cellular operators and partly explains the preference shown by existing cellular operators to migrate towards LTE[3].

B. *Frequency Bands*

The frequency bands that LTE and WiMAX are expected to be deployed are quite different. This is also related to the fact that cellular operators are expecting to use existing frequency bands for LTE usage in the future

C. *Uplink Transmission*

WiMAX deploys OFDMA in uplink and down- link directions. LTE deploys OFDMA on the down- link but SC-FDMA (Single Carrier- Frequency Di- vision Multiple Access) on the uplink. The choice of SC-FDMA is motivated by reducing the PAPR (Peak to Average Power Ratio) on the uplink. PAPR ratio has a direct impact on the requirements of the power amplifier and resulting battery life. (OFDM transmissions consist of multiple subcarriers leading to a relatively larger PAPR than those for a single-carrier.) SC-FDMA provides a 1-2 dB PAPR advantage

over OFDMA that in turn improves battery life of subscriber devices (SC-FDMA would increase receiver complexity at the BS compared to OFDMA receiver). This improvement is available to users at the edge of the cell.[7]

D. ***Frame Duration***

LTE uses a frame of 1 msec while WiMAX uses a frame of 5 msec. The shorter duration leads to more complex implementation in the form of larger processors, etc. However, this reduces end-end latency and can lead to improved H-ARQ (Hybrid ARQ) performance, faster channel quality feedback channel.

Remarks	
Duplexing Mode	LTE is primarily for FDD (though TDD is defined). WiMAX is primarily for TDD (though FDD is being considered)
Frequency Bands	LTE: 700, 1700, 1900, 2100, 2500, 2600 WiMAX: 2300, 2500 and 3500
Uplink Transmission	LTE: SC-FDMA WiMAX: Uplink Transmission is OFDMA
Frame Duration and SubCarrier Frequncy	LTE: 1 msec frame; subcarrier frequency :15KHz WiMAX: 5 msec frame; subcarrier frequency : 10KHz

Table 2 provides the key similarities between LTE and WiMAX air Interface.[4]

E. ***Latency***

There is a good difference in the latency of WiMax and LTE, and some ”real time” multimedia services will get benefit of this. Latency is a key point in some online services, and if one wants to deliver these services in a good way, he will need to pay attention to the Latency parameter In some cases the signal must arrive at its destination as soon as possible, in order to maintain a ”real time” sensation during the data exchange over the net: Online gaming and videoconference. Online gamers always complain about the ”ping”. In competitive gaming there is a huge difference between players whether one of them has 40ms less than others. The videoconferences will have better performance, without delays in the conversation. There is a solution to a high latency: the use of buffers, that’s true.

But there is a point here for LTE, because it do not need special improvements. Also, WiMax uses a bigger overhead in the packets, and that is worse for services like VoIP.

F. ***Handover and Roaming***

LTE supports handover and roaming with the 3GGP mobile networks. However, these services are not easy to achieve with WiMax. This fact is an important point because the roaming service generates numerous benefits for operators: it extends their coverage of the operator using the network of other carriers, it generates more benefits of visitors from other carriers and it provides to users an important service: One can travel far away from the coverage of his operator and the mobile phone is still functional.[6]

G. ***Use of a SIM card***

LTE, like GSM, needs a SIM card to operate. The use of a SIM card has its advantages and also its disadvantages. On the one hand, with LTE, the use of a SIM card is mandatory for the users and that is a requirement for them, which is not good because the users want things easy, so the fewer requirements needed the better. On the other hand, the use of SIM card makes easier to provide some services like roaming, which is a key service nowadays. Identifying subscribers with a SIM makes things easier to the carrier[2].

H. ***Power consumption***

LTE needs lower power consumption than WiMax. One of the reasons of this is the use of SC-FDMA modulation in uplink channels. A low power consumption results in a longer battery life in mobile devices. So LTE has an advantage here, when talking about mobility, the battery life is a main feature of any mobile device like a mobile phone. Talking about bigger devices, like laptops, the battery is not an important issue because batteries of these devices last longer. Different carrier, different situations

V. SIMILARITIES

OFDMA(Orthogonal Frequency Division Multiple Access) on downlink MIMO(Multiple Input Multiple Output) and beam forming; Backward compatibility; Speed; Error correcting codes- Viterbi and turbo coding; IP based technologies; Scalable Bandwidth.[5]

VI. CONCLUSION

In this paper, the differences and similarities between those technologies were outlined. The success of these technologies can be determined by a combination of both business and technology factors , from the study point of view , the business factors will play the biggest role in determining the success of LTE and WIMAX . Although LTE and WiMAX have deployed similar air interface technology (OFDMA, MIMO) , these technologies have considerably different implementations . Another effective factor which will ultimately decide which technology to be widely deployed is the unique advantage for both LTE and WiMAX . For operators using third generation (3G) it’s a clear choice to go with LTE deployment .while WIMAX will be more than satisfying for operators working on spectral range of 2.5 GHz and 3.5 GHz.

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